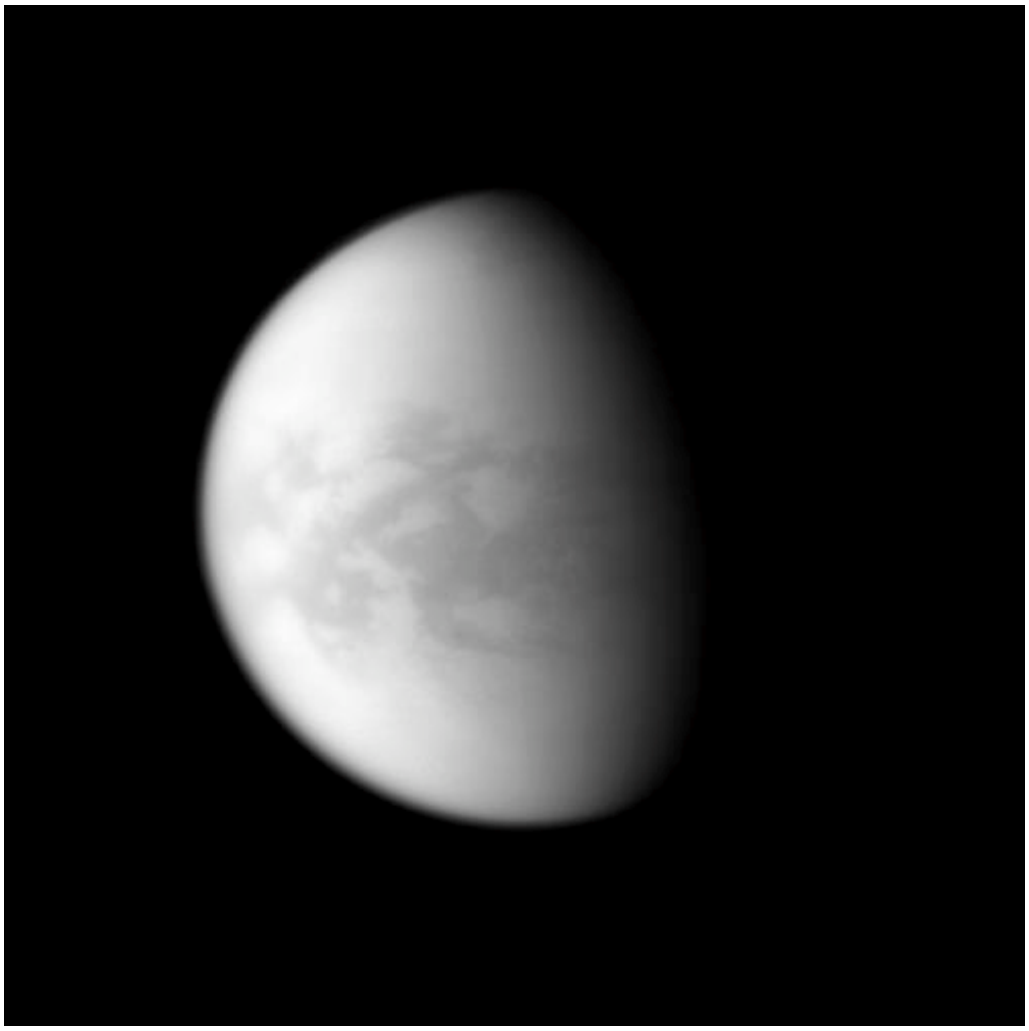
C A S S I N I



T I T A N 1 1 5 T I (T 5 9)
MISSION DESCRIPTION

July 24, 2009

Jet Propulsion Laboratory
California Institute of Technology

Cover image: Centered on Senkyo

The Cassini spacecraft examines the dark region of Senkyo on Saturn's largest moon, Titan.

Senkyo is in the center of the image, and it lies just south of the moon's equator. For an earlier view of this region, see Fascinating F Ring.

Lit terrain seen here is on the Saturn-facing side of Titan (5150 kilometers, or 3200 miles across). North on Titan is up and rotated 6 degrees to the left. The image was taken with the Cassini spacecraft narrow-angle camera on March 21, 2009 using a spectral filter sensitive to wavelengths of near-infrared light centered at 938 nanometers. The view was obtained at a distance of approximately 994,000 kilometers (618,000 miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 63 degrees. Image scale is 6 kilometers (4 miles) per pixel.

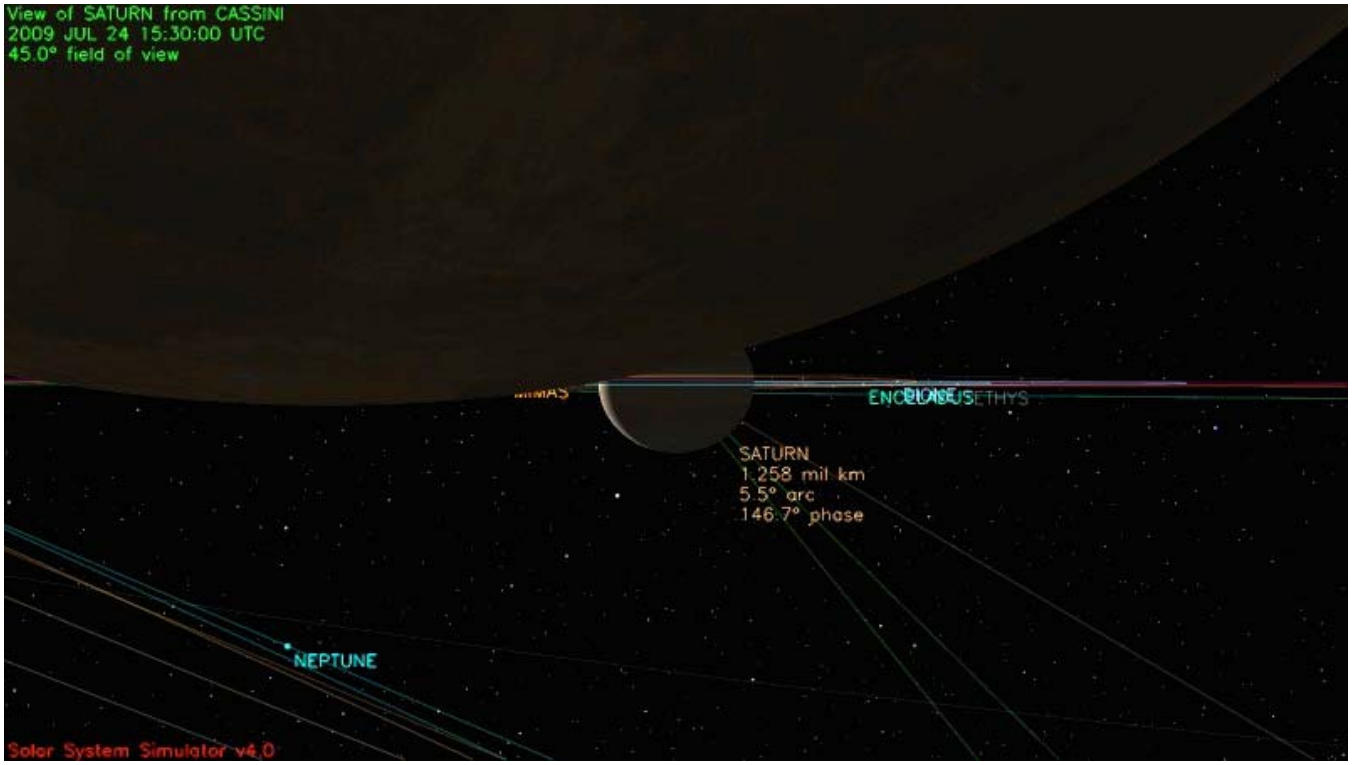
The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

One fortnight and two days (16 days total) since its previous visit, Cassini returns to Saturn's largest moon for the mission's sixtieth targeted encounter with Titan. The closest approach to Titan occurs on Friday, July 24 at 205T15:34:03 spacecraft time at an altitude of 955 kilometers (~593 miles) above the surface and at a speed of 6.0 kilometers per second (~13,400 mph). The latitude at closest approach is 62 degrees S and the encounter occurs on orbit number 115.

This encounter is set up with two maneuvers: an apoapsis maneuver on July 17, and a Titan approach maneuver, scheduled for July 21. T59 is the eighth flyby in a series of eleven inbound encounters and the fifteenth Titan encounter in Cassini's Solstice Mission. It occurs just slightly more than two days before Saturn closest approach.

This shows the view from the spacecraft 5 minutes before Titan closest approach.



ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.1 TITAN-59 SCIENCE HIGHLIGHTS

- **CAPS** takes advantage of a rare opportunity to determine the spacecraft's pointing near Titan closest approach. On this flyby, Titan is in the pre-midnight region of Saturn's magnetosphere, and the spacecraft's trajectory will cross over the south pole. The flyby allows for a full sampling of inbound interaction region inside of 12 Titan radii. Though CAPS can collect data as a "rider" (where another instrument chooses the pointing), the data is fragmentary. It's difficult to combine partial coverage from many encounters into one coherent view. The only other Titan flyby with CAPS prime data was T15 (T5 also had CAPS prime, but the data were not successfully downlinked). CAPS also takes part in a combined observation at closest approach of Titan's ionosphere with INMS.
- **INMS** makes a prime observation on the night side of Titan at high Southern latitudes. This is one of two high Southern latitude passes that will help fill in the latitude coverage of Titan's atmosphere. Because of high latitude, the spacecraft is riding along the terminator. This allows INMS to bserve Titan's atmosphere during the transition from day to night. CIRS takes part in the closest approach observations in a "partnership", not just ridealong.
- **RADAR** observes a ridelong SAR during INMS's observations at closest approach. The SAR swath runs parallel to observations in the T55-58 southern hemisphere mapping sequence covering south polar terrain.
- **CIRS** conducts far-infrared vertical scanning and integration near 55 degrees south, including vertical temperature and aerosol sections. Mid-IR sounding in north for temperature (0-60°N) and composition (65°N) provides insights into seasonal change of thenorth polar vortex. CIRS combines measurements with CAPS during CAPS prime time on this low flyby.
- **UVIS**: UVIS will obtain an image cube of Titan's atmosphere at EUV and FUV wavelengths by sweeping its slit across the disk. These cubes provide spectral and spatial information on nitrogen emissions, H emission and absorption, absorption by simple hydrocarbons, and the scattering properties of haze aerosols. This is one of many such cubes gathered over the course of the mission to provide latitude and seasonal coverage of Titan's middle atmosphere and stratosphere.
- **ISS** has no illuminated prime observations on this flyby.

- **VIMS** has no prime images on this dark flyby.
- **MIMI** measures energetic ion and electron energy input to Titan's atmosphere.
- **MAG**: T59 is a polar (south), post-dusk close flyby. MAG measurements will provide a description of the draping and the pileup of the external magnetic field around Titan on the nightside hemisphere/terminator. It will be also a good complement to T52, T53, T54, T55, T56, T57 and T58 in order to characterize the background field for a similar local time with respect to Saturn and different SKR longitudes.
- **RPWS** will measure thermal plasmas in Titan's ionosphere and surrounding environment; search for lightning in Titan's atmosphere; and investigate the interaction of Titan with Saturn's magnetosphere.

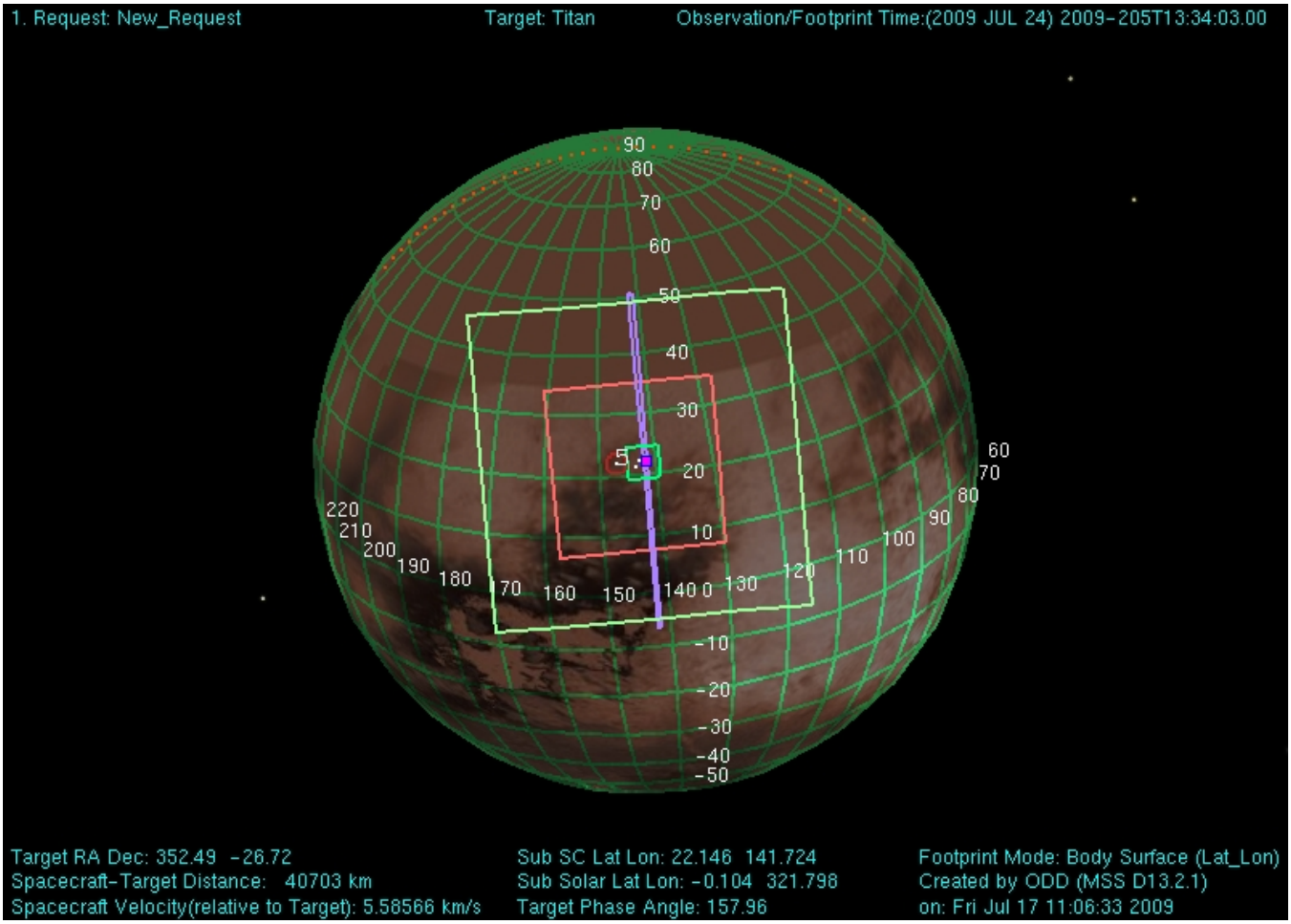
SAMPLE SNAPSHOTS

Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

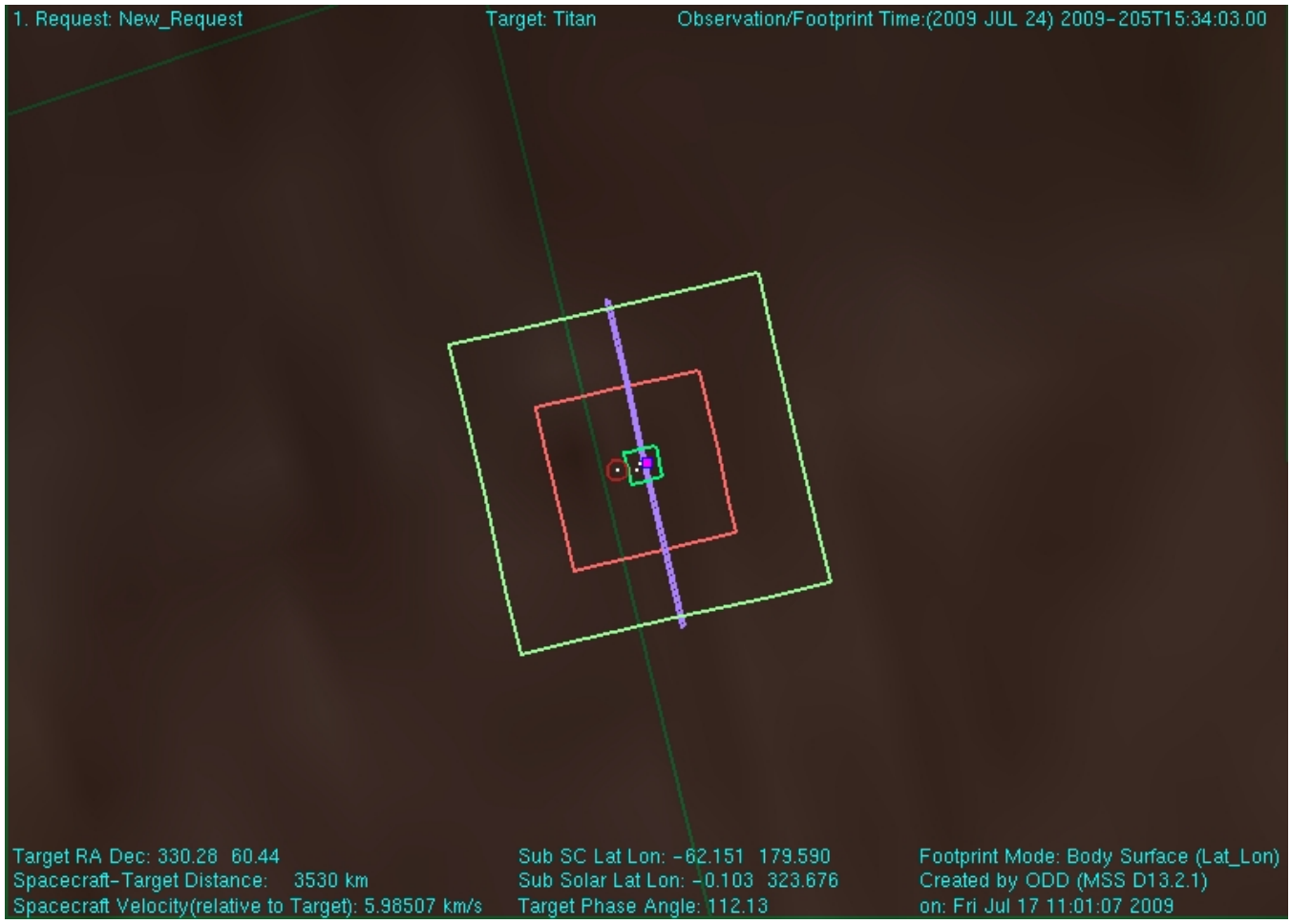
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

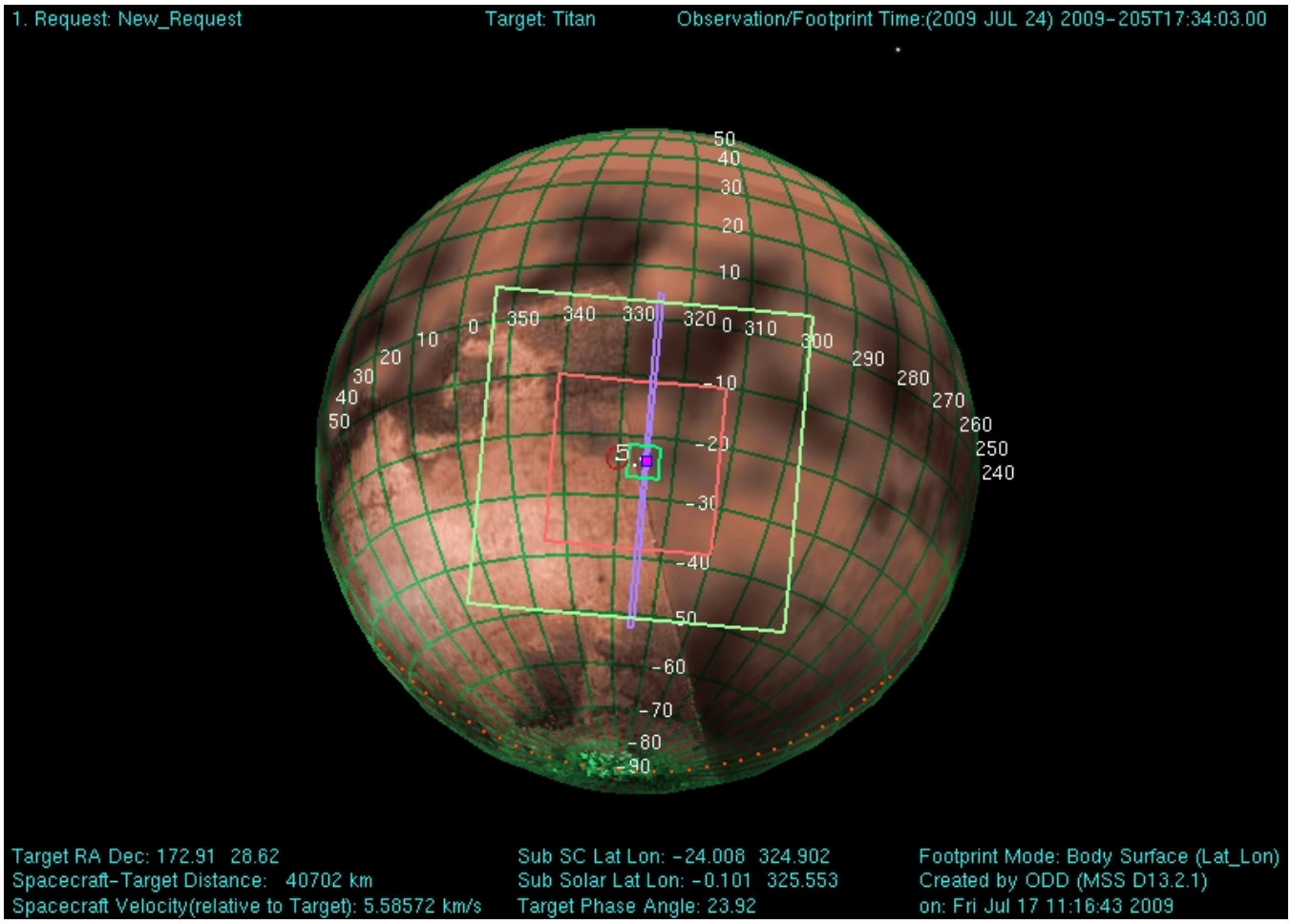
View of Titan from Cassini two hours before Titan-59 closest approach



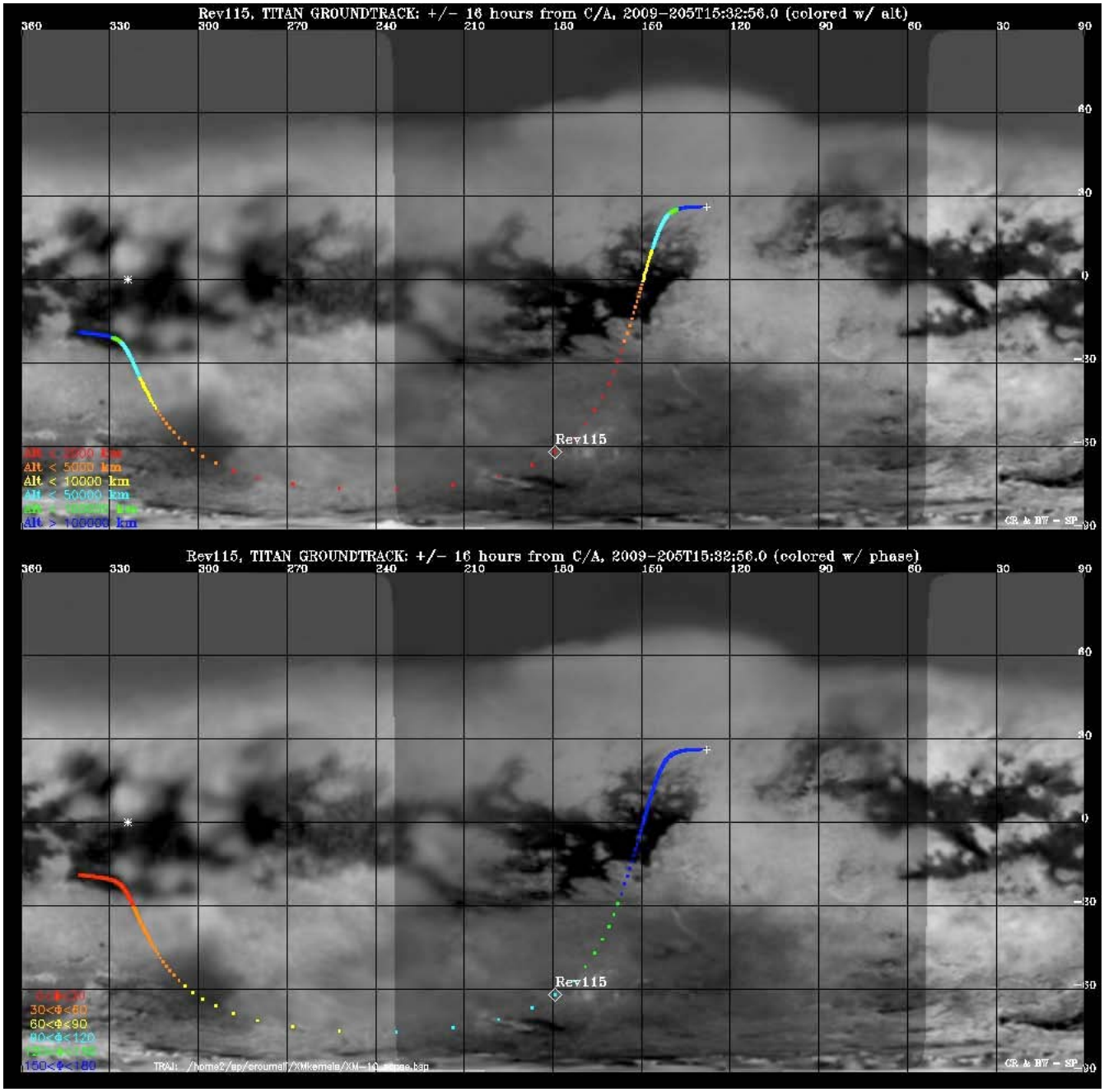
View of Titan from Cassini at Titan-59 closest approach



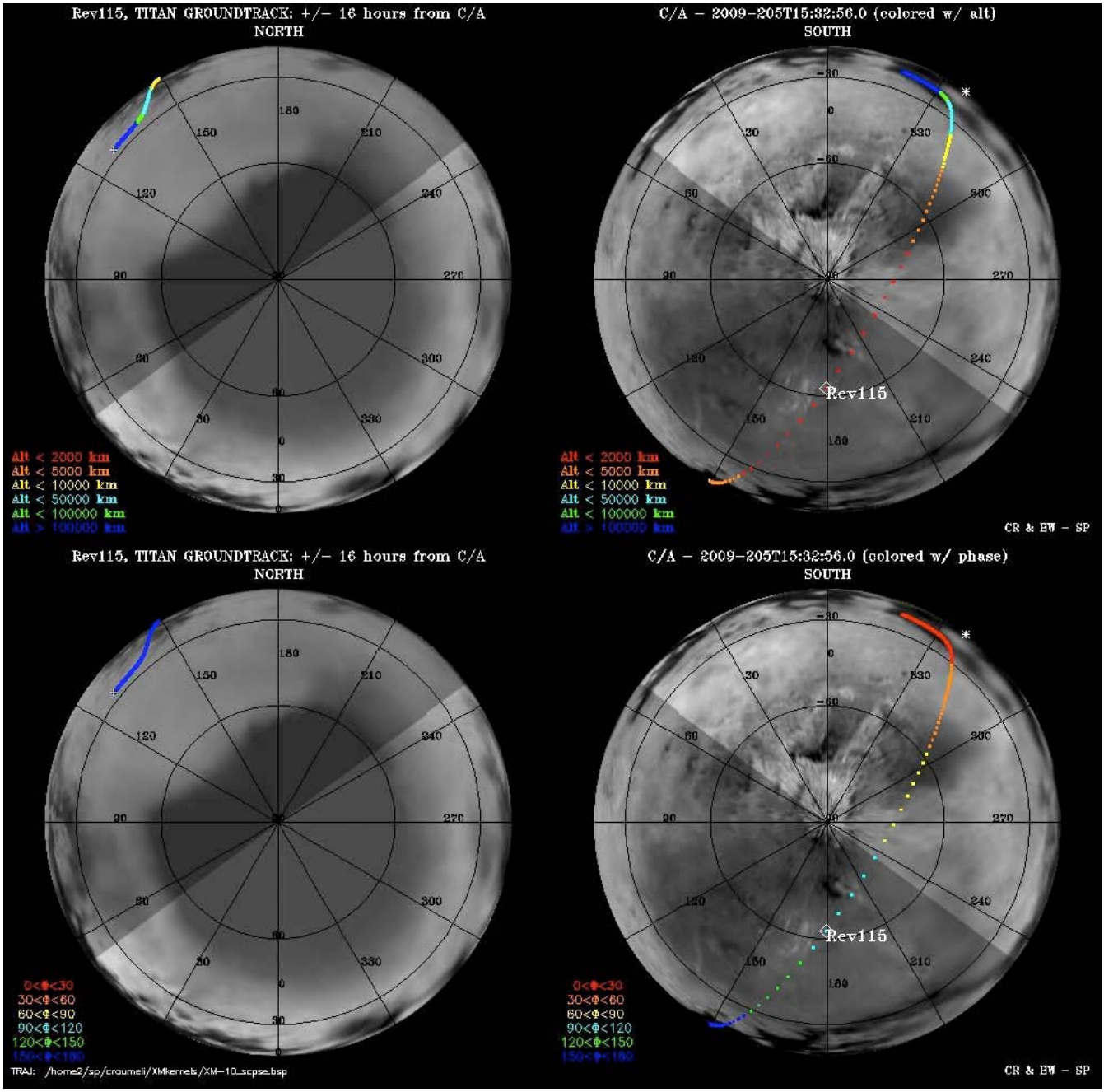
View of Titan from Cassini two hours after Titan-59 closest approach



Titan Groundtracks for T59: Global Plot



Titan Groundtracks for T59: Polar Plot



The T59 timeline is as follows:

Orbiter UTC	Ground UTC	Pacific Time (PDT)	Time wrt T59	Activity	Description
204T21:51:00	Jul 23 23:15	Thu Jul 23 04:15 PM	T59-17h43m	Start of Sequence S52	Start of Sequence which contains Titan-59
202T09:36:00	Jul 21 11:00	Tue Jul 21 04:00 AM	T59-03d06h	OTM #208 Prime	Titan-59 targeting maneuver.
203T09:36:00	Jul 22 11:00	Wed Jul 22 04:00 AM	T59-02d06h	OTM #208 Backup	
204T21:51:00	Jul 23 23:15	Thu Jul 23 04:15 PM	T59-17h43m	Start of the TOST segment	
204T21:57:00	Jul 23 23:21	Thu Jul 23 04:21 PM	T59-17h37m	Turn cameras to Titan	
204T22:37:00	Jul 24 00:01	Thu Jul 23 05:01 PM	T59-16h57m	New waypoint	
204T22:37:00	Jul 24 00:01	Thu Jul 23 05:01 PM	T59-16h57m	Deadtime	10 minutes 07 seconds long; used to accommodate changes in flyby time
204T22:47:07	Jul 24 00:11	Thu Jul 23 05:11 PM	T59-16h47m	Titan surface observations-ISS	Nightside NAC imaging
204T23:34:03	Jul 24 00:58	Thu Jul 23 05:58 PM	T59-16h00m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
205T02:34:03	Jul 24 03:58	Thu Jul 23 08:58 PM	T59-13h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0
205T05:34:03	Jul 24 06:58	Thu Jul 23 11:58 PM	T59-10h00m	Titan atmospheric observations-ISS	WAC photometry
205T06:34:03	Jul 24 07:58	Fri Jul 24 12:58 AM	T59-09h00m	Titan atmospheric observations-CIRS	Obtain vertical profiles of temperatures in Titan's stratosphere. The arrays are stepped along the limb at two altitudes at 5 degree latitude intervals.
205T10:34:03	Jul 24 11:58	Fri Jul 24 04:58 AM	T59-05h00m	Titan surface observations-VIMS	Regional mapping
205T13:34:03	Jul 24 14:58	Fri Jul 24 07:58 AM	T59-02h00m	Titan MAPS campaign-CAPS	
205T14:47:03	Jul 24 16:11	Fri Jul 24 09:11 AM	T59-00h47m	Transition to thruster control	
205T14:48:03	Jul 24 16:12	Fri Jul 24 09:12 AM	T59-00h46m	Titan MAPS campaign-CAPS	
205T15:15:03	Jul 24 16:39	Fri Jul 24 09:39 AM	T59-00h19m	RADAR/INMS	RADAR SAR riding along with INMS MAPS observation
205T14:52:28	Jul 24 16:16	Fri Jul 24 09:16 AM	T59-00h42m	Earth occultation	38 minute duration
205T14:56:09	Jul 24 16:20	Fri Jul 24 09:20 AM	T59-00h38m	Solar occultation	34 minute duration
205T15:34:03	**Jul 24 16:58**	**Fri Jul 24 09:58 AM**	**T59+00h00m**	**Titan-59 Flyby Closest Approach Time**	**Altitude = 955 km (~593 miles), speed =6.0 km/s (13,400 mph); 112 deg phase at closest approach**
205T15:49:03	Jul 24 17:13	Fri Jul 24 10:13 AM	T59+00h15m	Titan atmospheric observations-CIRS	Titan Occults Eta UMa
205T16:04:36	Jul 24 17:28	Fri Jul 24 10:28 AM	T59+00h30m	Descending Ring Plane Crossing	
205T16:24:03	Jul 24 17:48	Fri Jul 24 10:48 AM	T59+00h50m	Titan atmospheric observations-CIRS	Limb scanning for aerosols.
205T16:54:03	Jul 24 18:18	Fri Jul 24 11:18 AM	T59+01h20m	Titan atmospheric observations-CIRS	Vertical sounding of stratospheric compounds on Titan, including H2O. Integrations at 2 locations on the limb displaced vertically.
205T17:49:03	Jul 24 19:13	Fri Jul 24 12:13 PM	T59+02h15m	Transition off of thruster control	
205T18:10:08	Jul 24 19:34	Fri Jul 24 12:34 PM	T59+02h36m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
205T20:34:03	Jul 24 21:58	Fri Jul 24 02:58 PM	T59+05h00m	Titan atmospheric observations-CIRS	Obtain vertical profiles of temperatures in Titan's stratosphere. The arrays are stepped along the limb at two altitudes at 5 degree latitude intervals.
205T22:34:03	Jul 24 23:58	Fri Jul 24 04:58 PM	T59+07h00m	Deadtime	6 minutes 56 seconds long; used to accommodate changes in flyby time
205T22:41:00	Jul 25 00:05	Fri Jul 24 05:05 PM	T59+07h07m	Turn to Earth-line	
205T23:21:00	Jul 25 00:45	Jul 24 17:45	T59+07h47m	Playback of T59 Data	Canberra 70m